



Laboratori d'Enginyeria Marítima
UNIVERSITAT POLITÈCNICA DE CATALUNYA



TRANSPORTE DE SEDIMENTOS EN LA PLATAFORMA CONTINENTAL DEL DELTA DEL EBRO: MODELIZACIÓN Y PREDICCIONES

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1. LIM-UPC, 2. IMEDEA, 3. SIMO

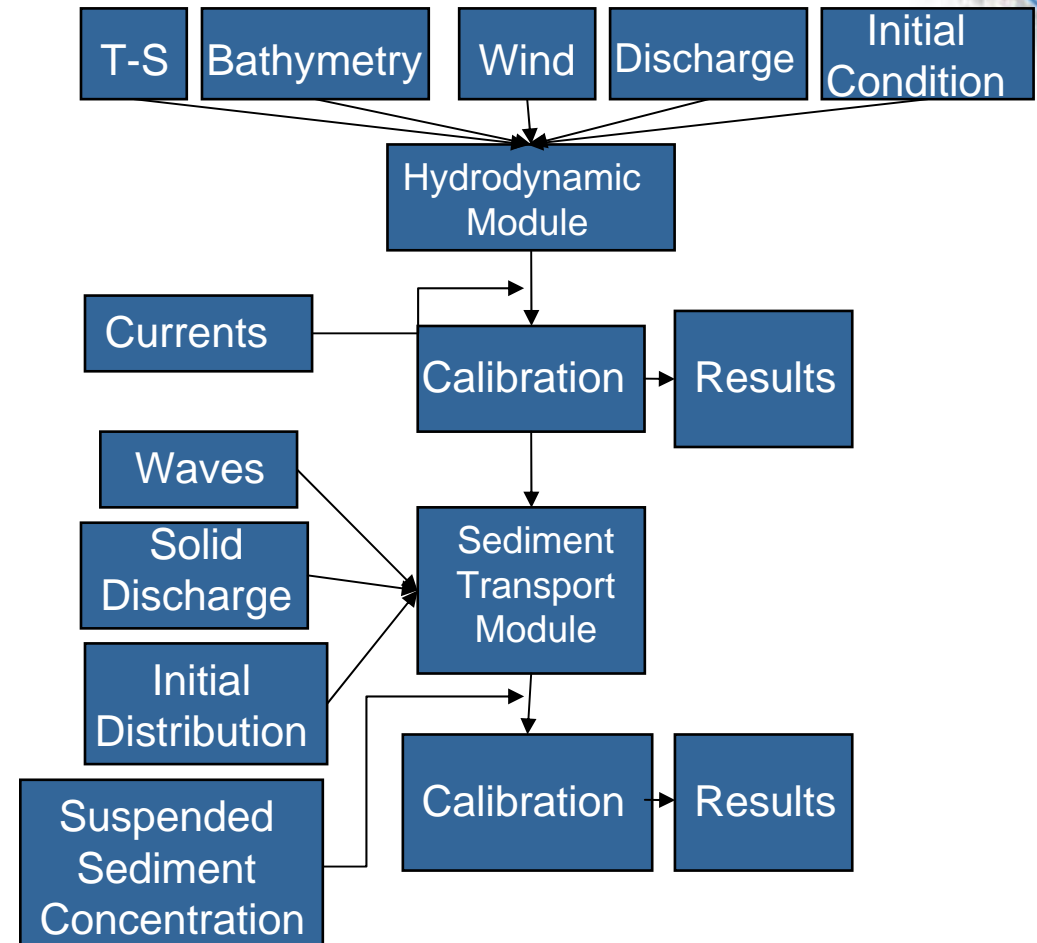


Introduction

- Importance of inner shelf – aquaculture, fisheries
- High suspended sediment concentration impact on biota
- High energy events transport great quantities of sediment from shallow waters to deeper ones.
- Some pollutants absorb to cohesive materials
- Lack of numerical studies of the sediment dynamics at a shelf scale
- The main objective of this presentation is to describe results from the implementation of a sediment transport model in the **Ebro Delta continental Shelf**, and forecasting possibilities

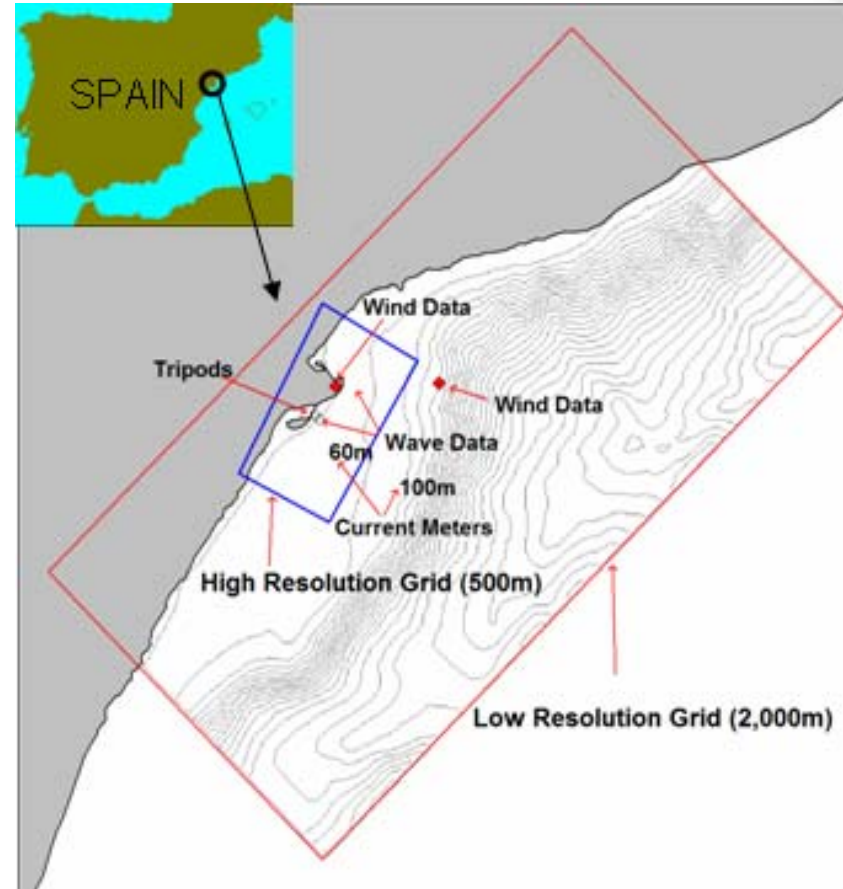
Numerical Model - Symphonie

- Pole d'Océanographie Cotiere in Toulouse
- 3D primitive equation model of the coastal ocean.
- Implemented and validated in different coastal and ROFI areas
- Sediment transport module
- Possibility of bed armouring
- Cohesive and non-cohesive material



Model Implementation – First Steps

- Low resolution grid (2000m)
- Nested high resolution grid (500m)
- The model potential vorticity method (MPV) - initialization technique
- Current and sediment transport model calibrated



Implementation and calibration

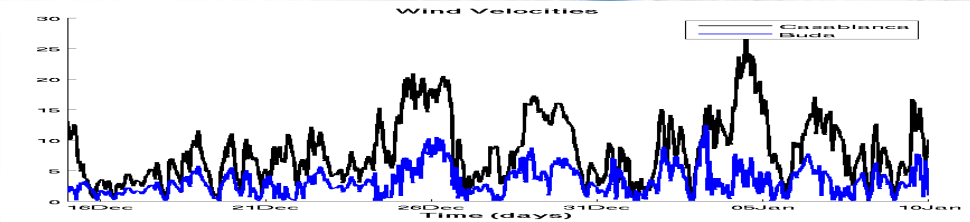
- Freshwater, stratification, grid size, vertical level number, roughness length and friction coefficient roles evaluated.
- Sediment transport module implemented for 4 non-cohesive class and one aggregate.
- Spin-up role analysed.
- Sediment transport parameters calibrated

Parameter	Value
Partheniades Resuspension coefficient	0.00004
Smith & McLean Resuspension Coefficient	0.00300
Transition criteria from Cohesive to Non Cohesive (% of clay)	0.04
Porosity (%)	0.73
Sediment density (kg/m ³)	2650
Clay Diameter (m)	2.0000E ⁻⁰⁶
Silt Diameter (m)	5.5000E ⁻⁰⁵
Fine Sand Diameter (m)	7.5000E ⁻⁰⁵
Coarse Sand Diameter (m)	1.1500E ⁻⁰⁴

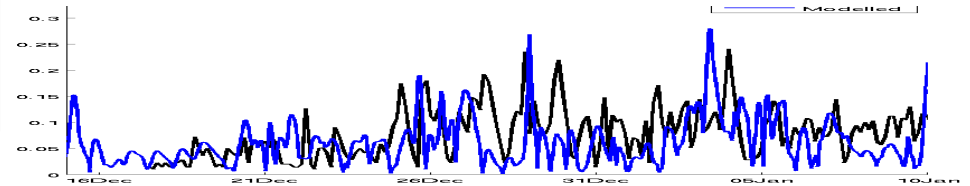
Period 1 – Dec 96 – Jan 97

- High river discharge
- North winds, intensity higher offshore, but same pattern onshore.
- High current velocities associated to watercourse and wind interactions.

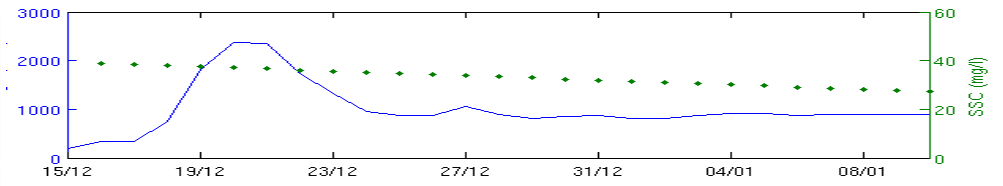
Wind Velocity



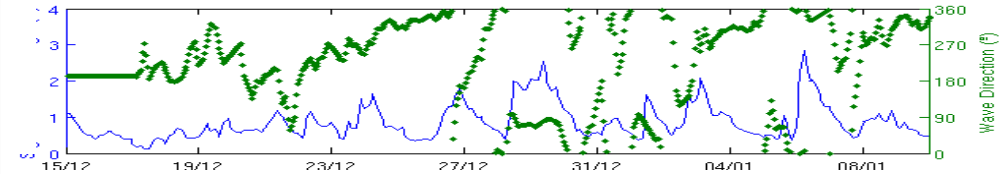
Current Velocity



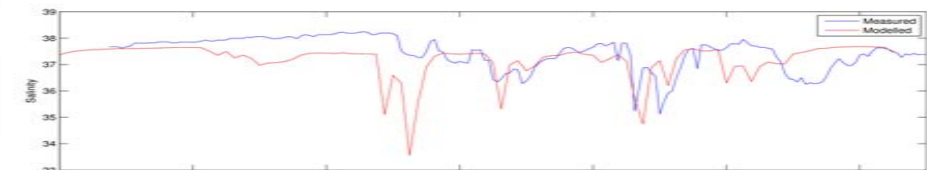
River Flow



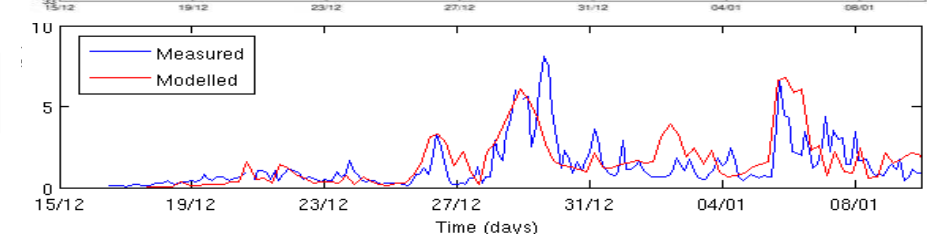
Wave Height - Direction



Salinity

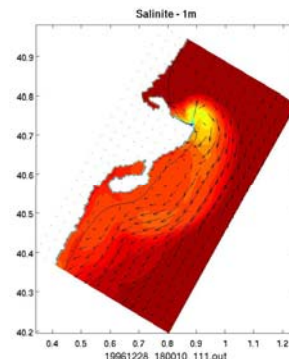


SSC (g/l)

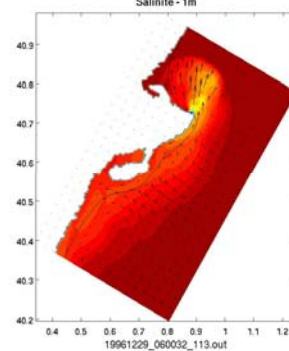
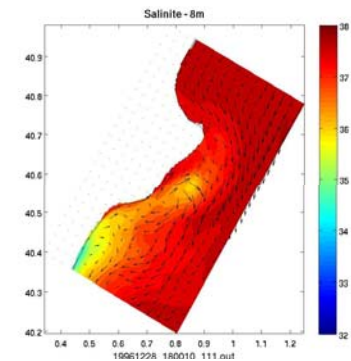


Period 1 – Salinity peak 2

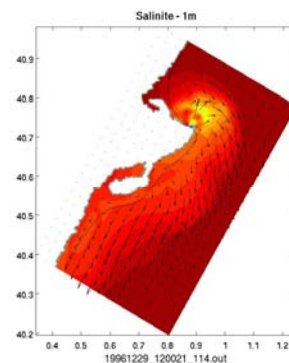
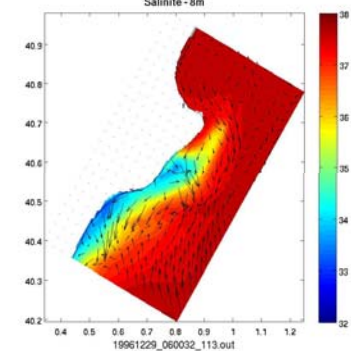
- River plume developed on surface
- Offshore winds narrow and deepen plume influence
- Wind relaxation creates baroclinic instability



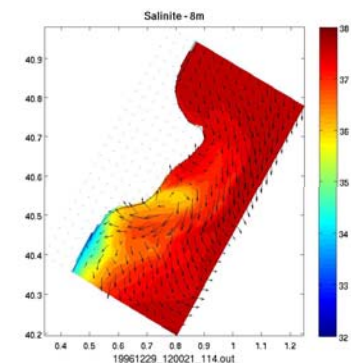
28/12/96
18:00



29/12/96
06:00



29/12/96
12:00

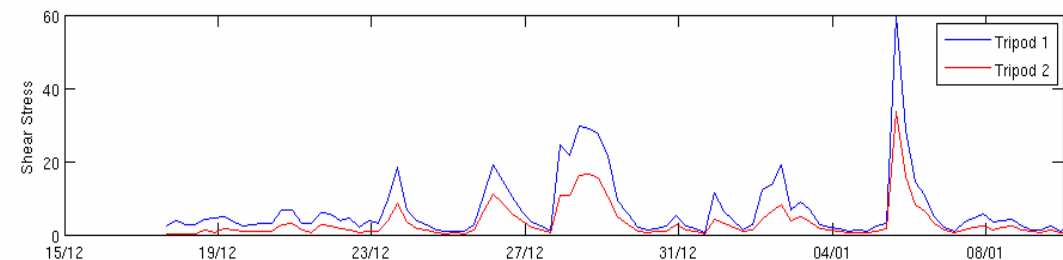
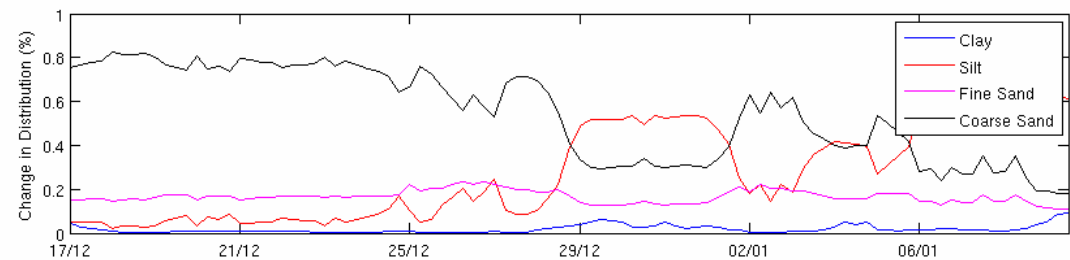
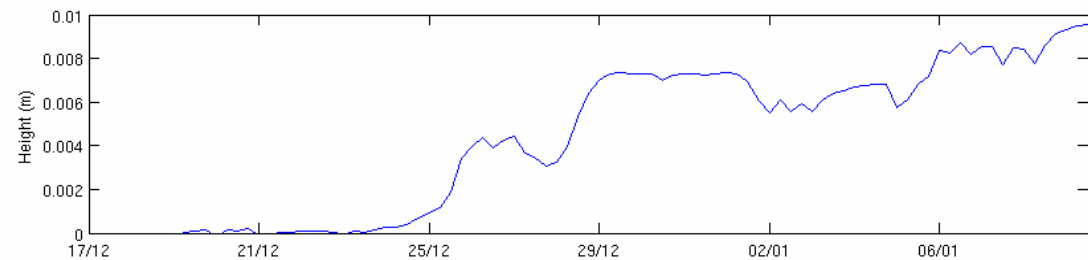


Salinity at 1m depth

Salinity at 8m depth

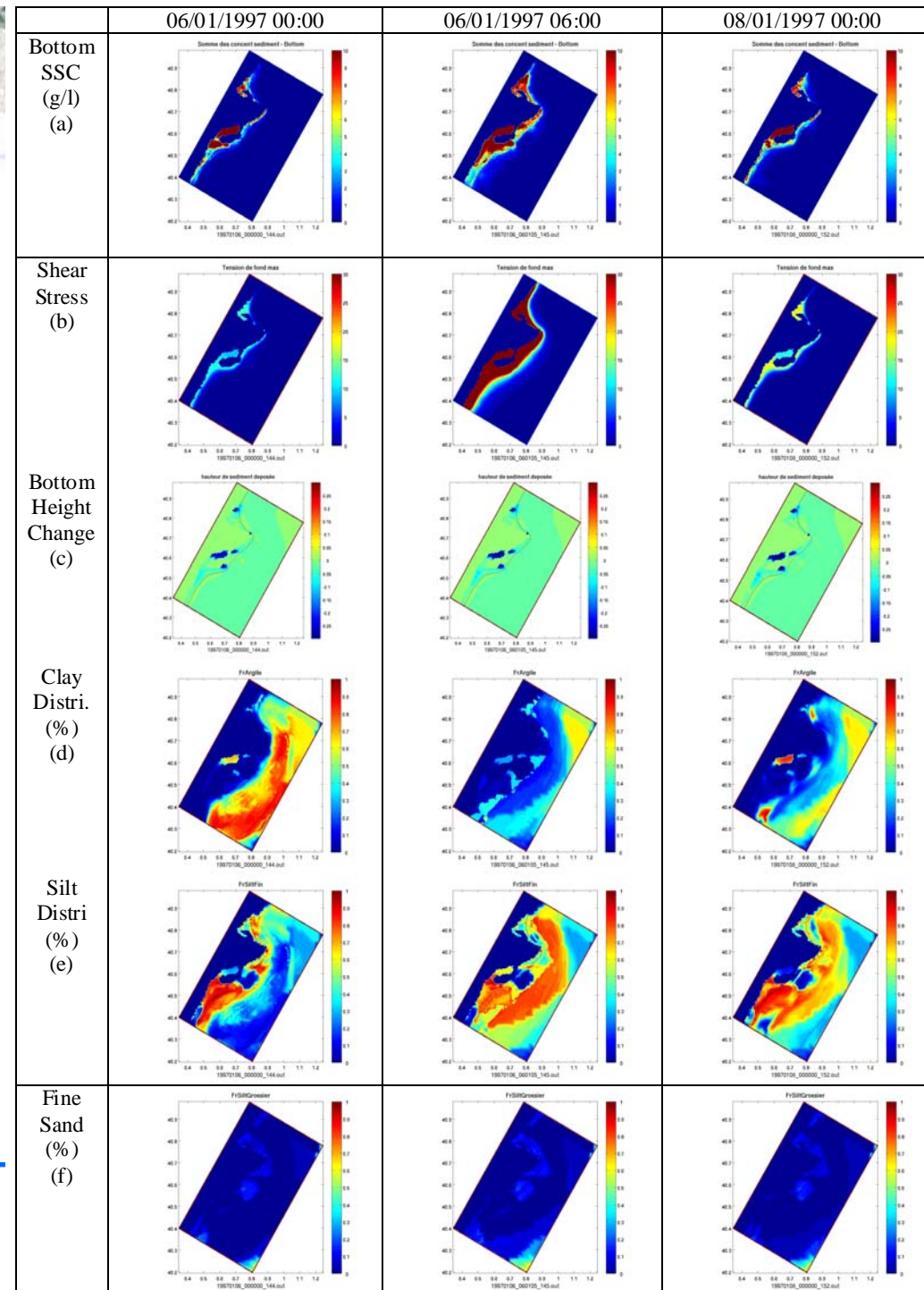
Height and Class Change – Period 1 – Tripod 1

- Height increases in Tripod 1 as reported by Guillen et al (2005)
- Height changes associated to silt deposition



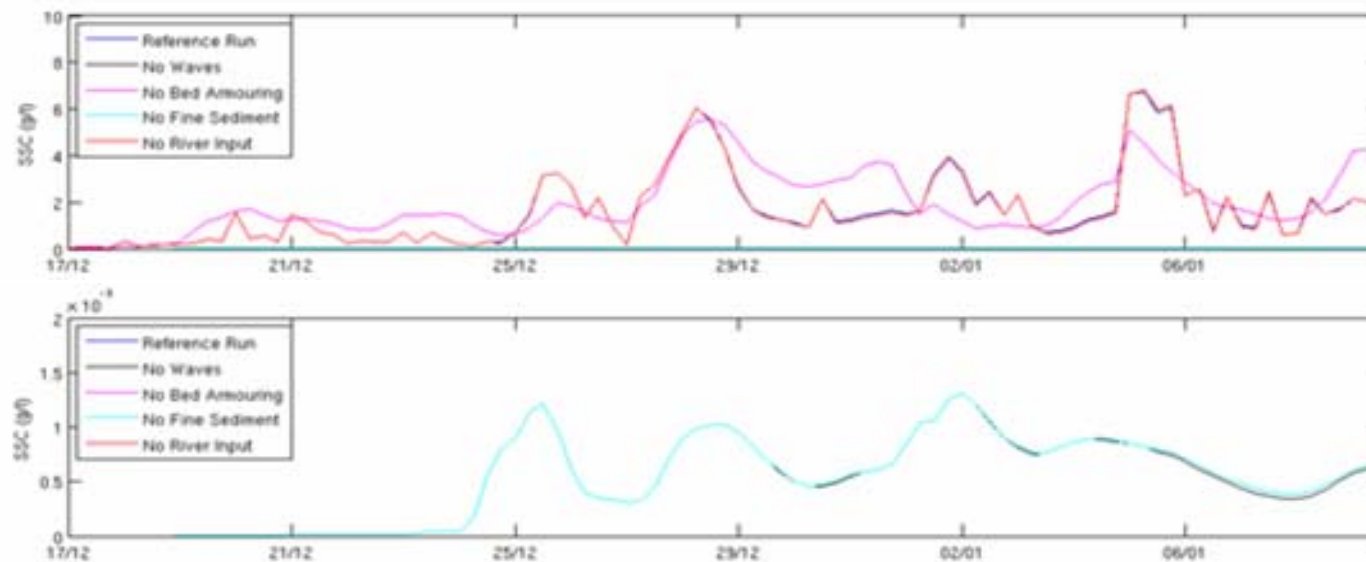
Height and Class Change – Period 1 – Whole Shelf

- Variables analyses around peak event
- Peak concentration around the Ebro Delta
- Clay material in suspension and off the model domain
- Silt becomes dominant class



Sediment Transport Sensitivity Tests

- No riverine input
- No waves
- No bed armouring
- No resuspension

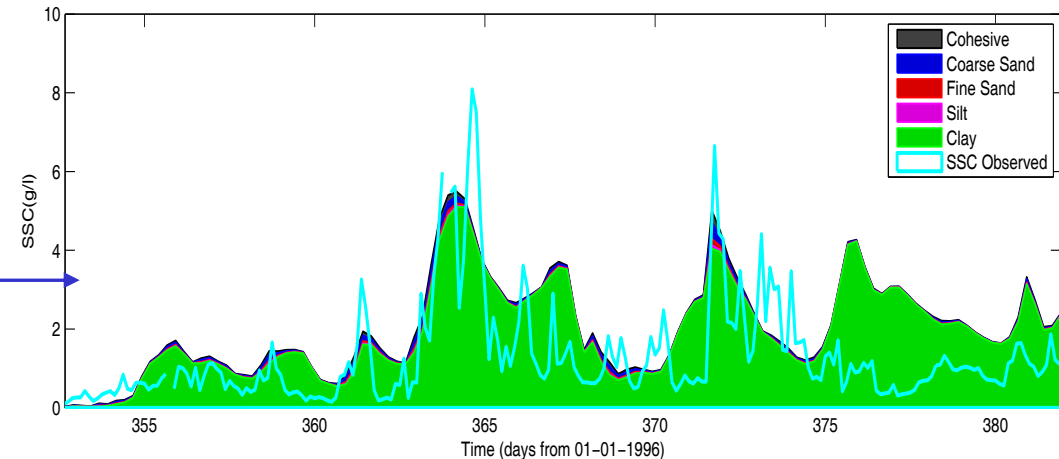


- Great influence of waves and bed armouring
- Poor influence of river and currents role (in tripods area)

Bed Armouring

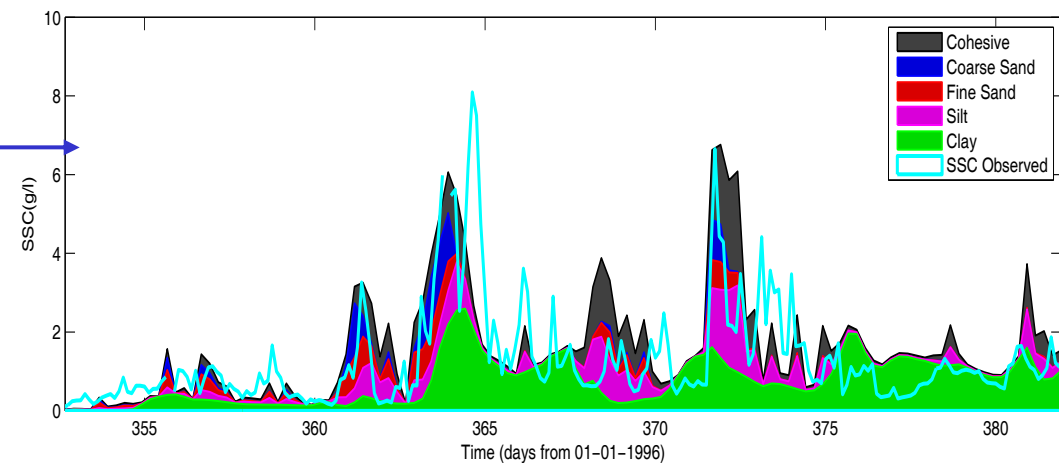
Bed armouring plays a major role in the model predictions

If bed armouring not included:
finer class (clay) dominant



If bed armouring is included:
other classes significant.

Bed armouring process limits
the availability of fine grains





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Analysis of Forecasting possibilities

Main objectives are:

- Assess the sources of information required and their reliability
- Assess the difficulties on implementing an operational sediment transport model
- Assess the results accuracy
- Implementation carried out from February 2009 to June 2009.
- All data sources were analysed and compared to actual recorded data (Spanish Port Authority and XIOM data).
- Results for three 15 days continuous events (from 15/02/2009 to 21/03/2009) will be presented

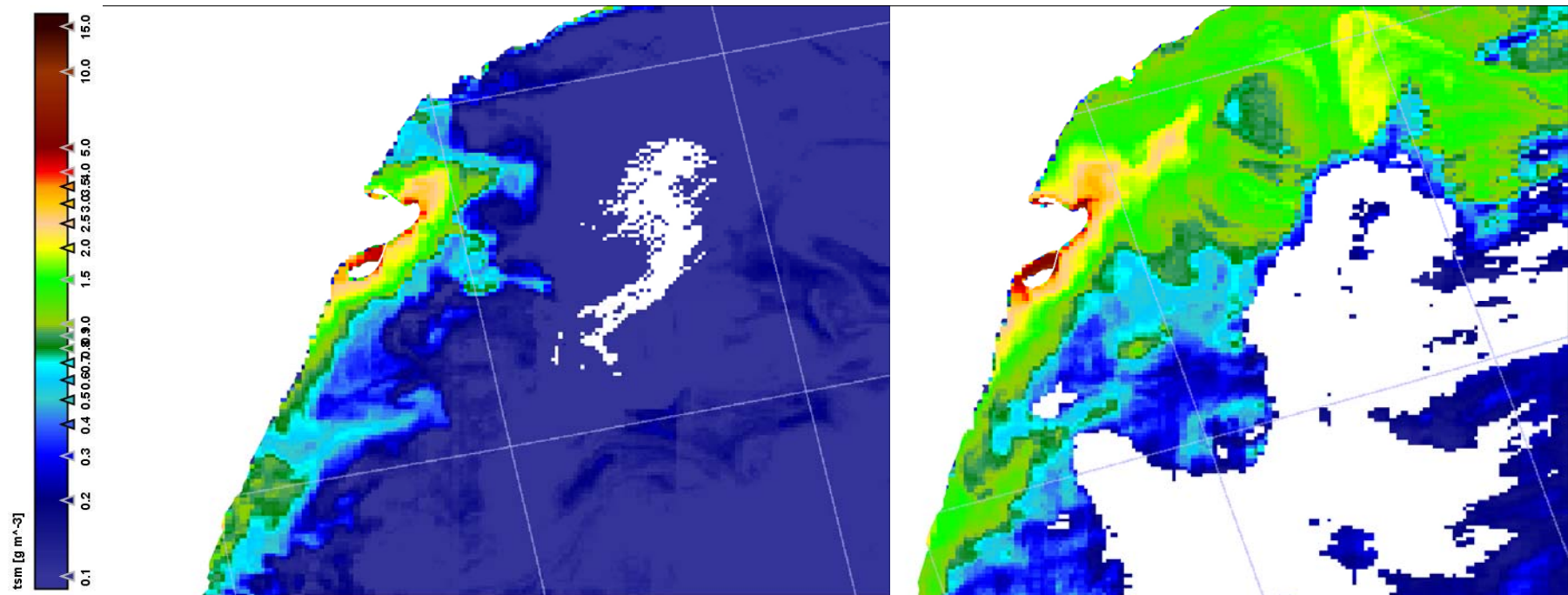


Hydrodynamic Data Sources

- Hydrodynamic boundary conditions have or will be obtained from:
 - MFS
 - MERCATOR
 - ESEOMED
- Wind data: information gathered from:
 - AEMET
 - SMC
- Wave data: information gathered from:
 - SMC
 - Puertos
- Watercourse data:
 - Operational hydrological model data could not be gathered. Recorded data used.
 - Ebro River SSC-discharge relationship formula used.

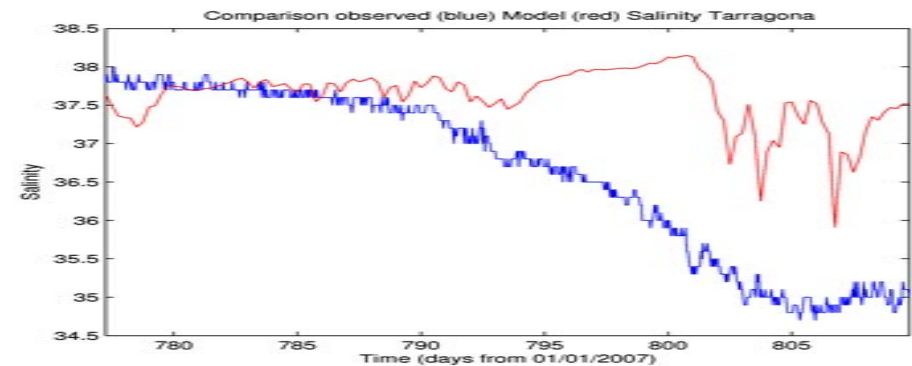
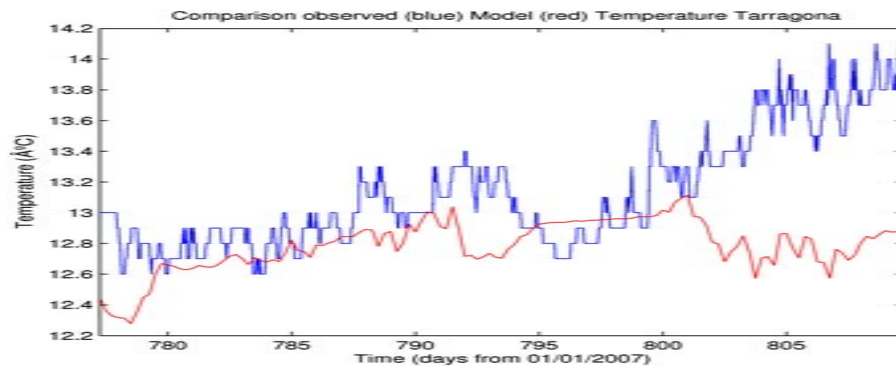
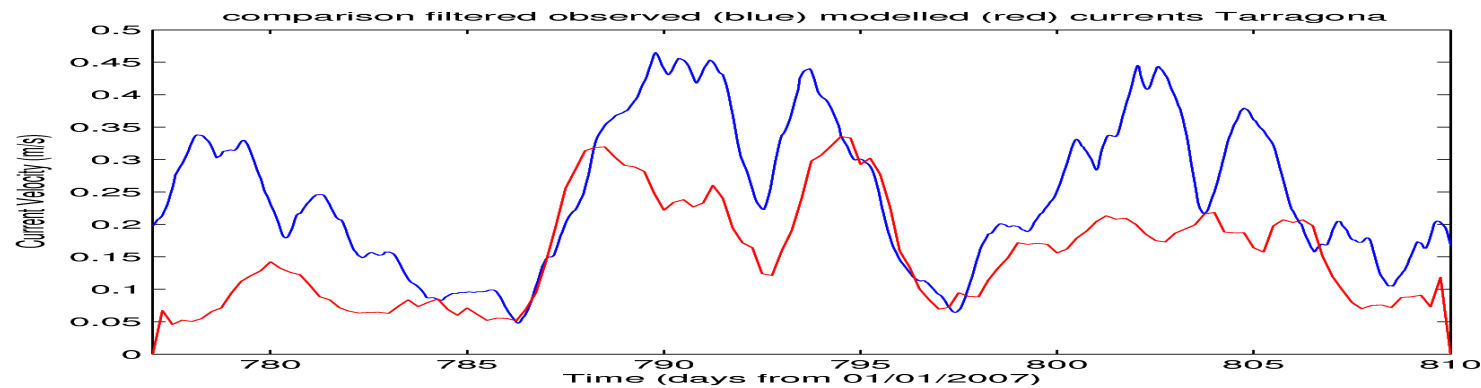
Sediment Transport Data Sources

- Satellite images: Meris case II satellite images. Analysed and processed using the MERIS case 2 Regional Processor (Doerffer and Schiller, 2008). Data used for validation.



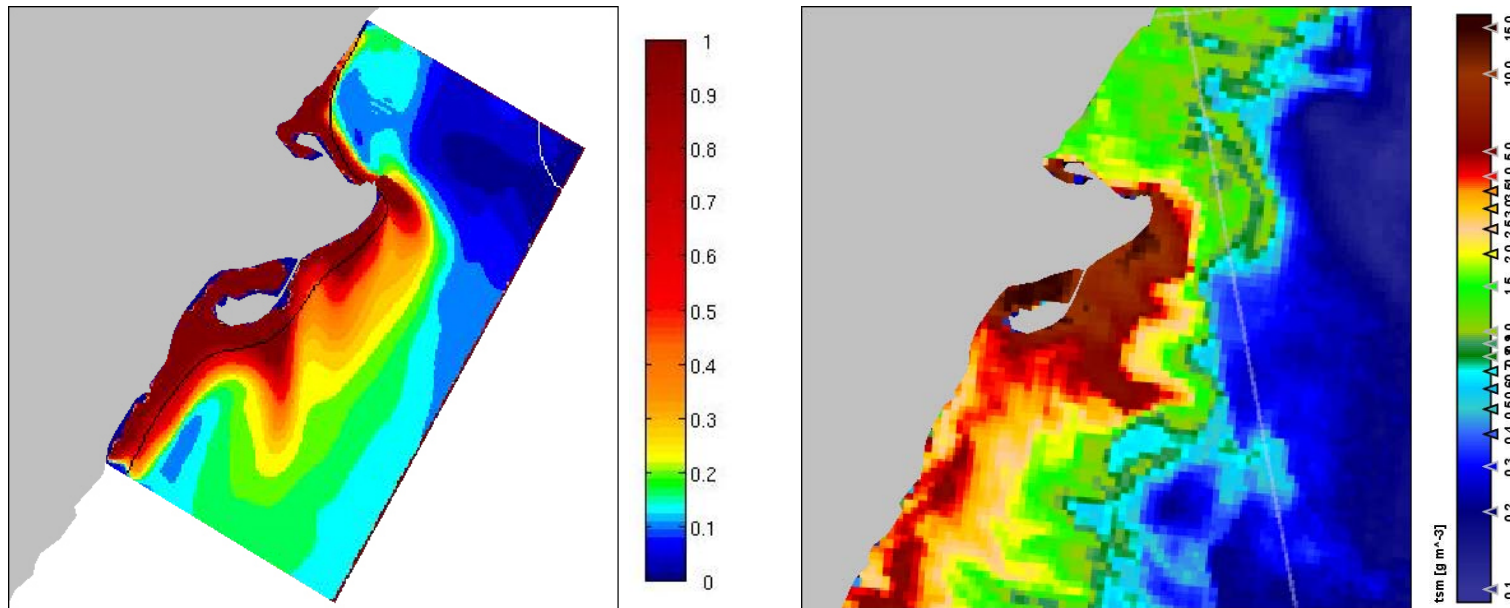
Validation Hydrodynamic Module

Current, temperature and salinity information from nearby buoys were used for the hydrodynamic model validation



Validation Sediment Transport Module

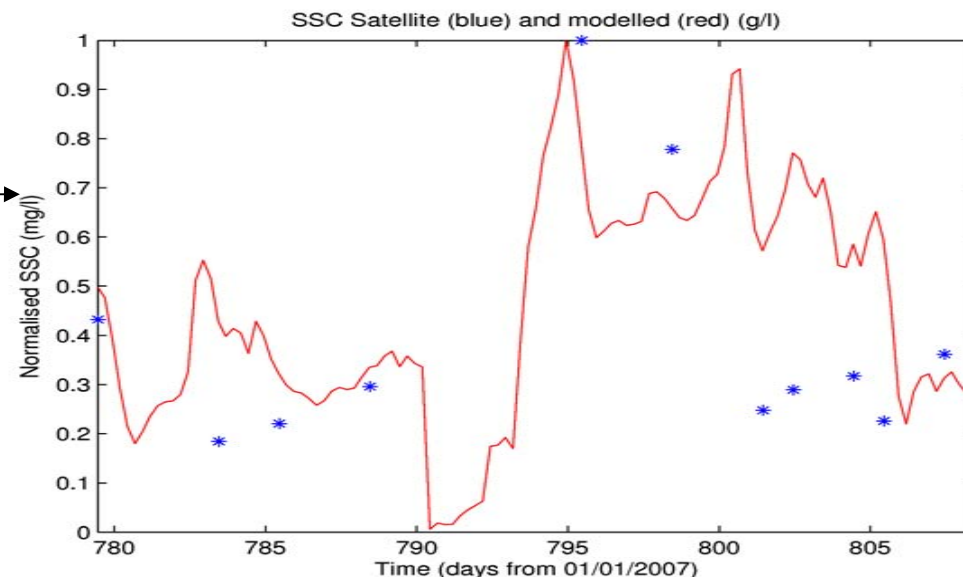
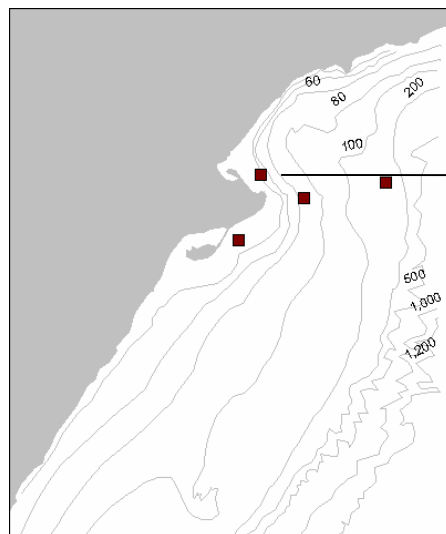
Satellite images were used for the sediment transport model validation



Total suspended sediment concentration (g/m³) for 06/03/09, model results (a) and satellite observations (b).

Validation Sediment Transport Module

Data from the satellite images at several surface points were compared to predicted data



Total suspended concentration (mg/l) comparison for recorded (blue stars) and predicted (red) data



Findings and Issues

- Satisfactory 1996-1997 events hydrodynamic and sediment transport model calibration.
- Satisfactory pre-operational hydrodynamic and moderately satisfactory sediment transport validation undertaken
- Issues found with watercourse data gathering
 - Operational discharge not available
 - SSC non-existing
- Data sources quality may affect accuracy results
- Future work
 - Initialisation techniques
 - Assessment of different data sources to improve results.